Introduction

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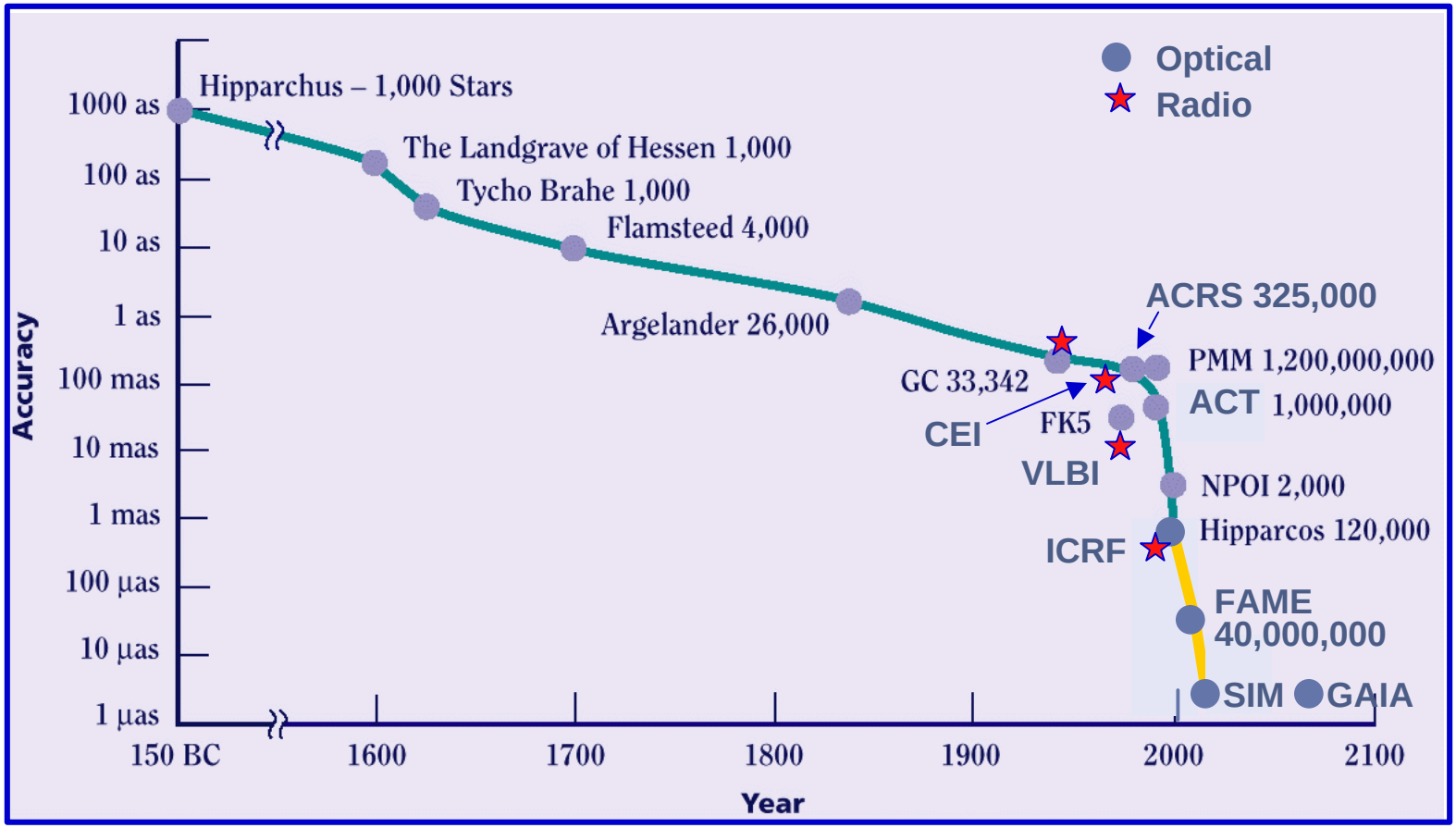
The Golden Age of Astrometry



Full-Sky Astrometric Mapping Explorer

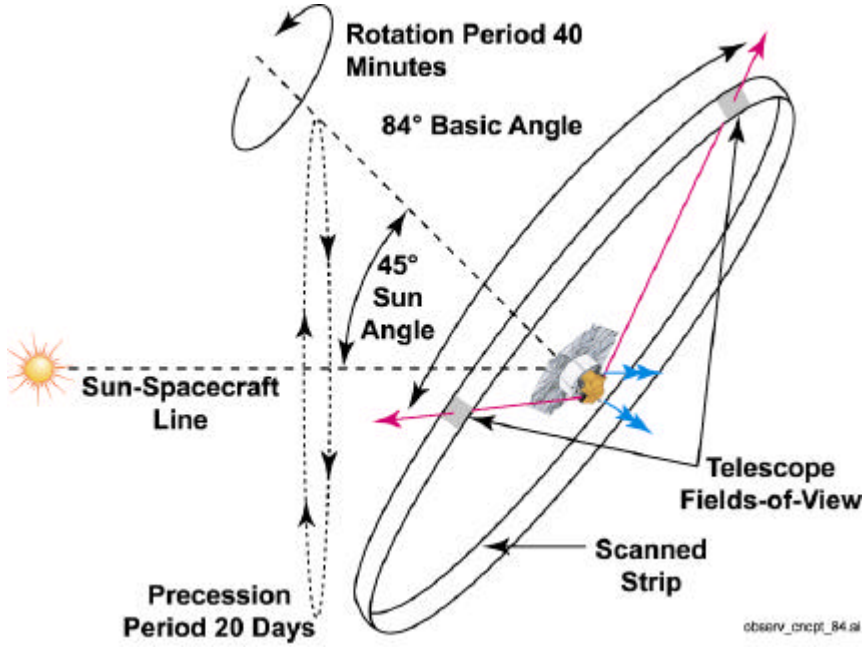
- **United States Naval Observatory**
  - **PI, Oversight of Science and Budget, MO&DA Lead, GDS, MOC, & SOC Development and Implementation, E/PO Lead**
- **Naval Research Laboratory**
  - **PM, System Engineering, S/C Bus Development, Integration, and Test, Comprehensive Testing**
- **Lockheed Martin Missiles and Space**
  - **Instrument Design, Fabrication, Testing, and Support**
- **Smithsonian Astrophysical Observatory**
  - **Synthesis and Verification of Scientific Measurement System, E/PO Support**

Technical Goals and Objectives of FAME

- **FAME Will Perform an All Sky, Astrometric Survey With Unprecedented Accuracy**
  - **Upgrades Existing Star Catalogs by Providing a Precision Catalog of $4x10^7$ Stars**
  - **Provides Positions of Bright Stars (5<mv<9) to <50mas**
  - **Provides Positions of Fainter Stars (9<mv<15) to <500mas**
  - **5 Year Extended Mission Allows for Accurate Measurement of Stellar Parallax, Proper Motions, and Monitoring of Stellar Variability**
  - **Photometric Data in Four Sloan DSS Bands (G', R', I', Z')**

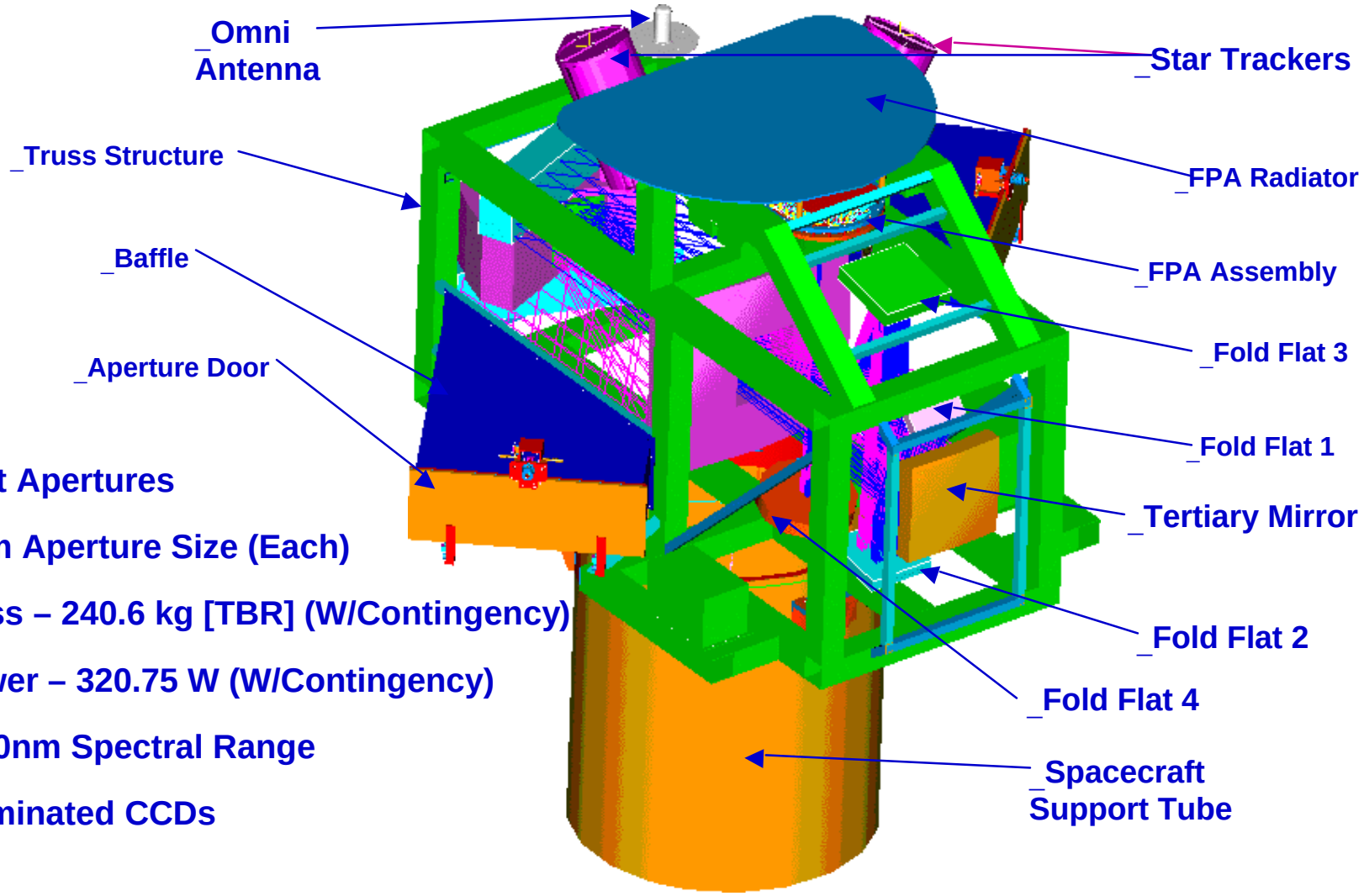
FAME Mission Description

- The Telescope Has Two Fields-of-View Separated by an 84° Basic Angle
- The Spacecraft Will Rotate With a 40 Minute Period With the Apertures Sweeping Out a Great Circle on the Sky
- The Spacecraft Rotation Axis Is at a 45° Angle to the Sun
- The Solar Radiation Pressure on the Solar Shield Results in Precession About the Sun-Spacecraft Line With a 20 Day Period
- The Spacecraft Is in Near Geosychronous Orbit for Continuous Contact



- The FAME Observing Concept
  - The Axis of the FAME Spacecraft Is Pointed 45° From the Sun and Precesses Around the Sun With a 20 Day Period
  - The FAME Spacecraft Rotates With a 40 Minute Period
  - The Two Fields of View Are Normal to the Rotation Axis and Are Separated by an 84° Degree Basic Angle

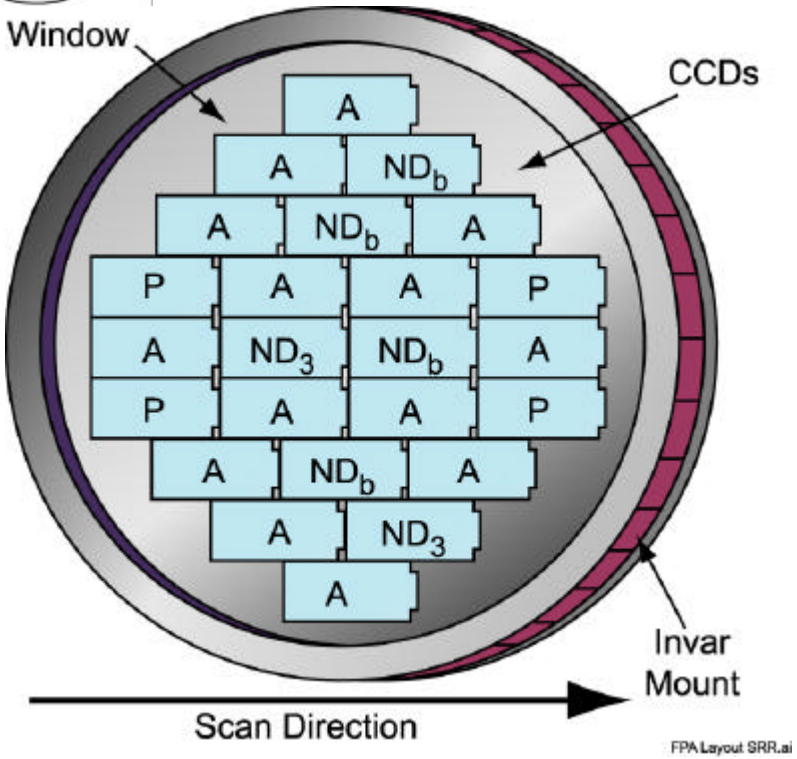
FAME Instrument Description (1 of 2)



- Two Input Apertures
- 56×13 cm Aperture Size (Each)
- Total mass – 240.6 kg [TBR] (W/Contingency)
- Total Power – 320.75 W (W/Contingency)
- 400 to 900nm Spectral Range
- Back Illuminated CCDs

Instrument developed by Lockheed Martin Missiles and Space ATC

FAME Instrument Description (2 of 2)



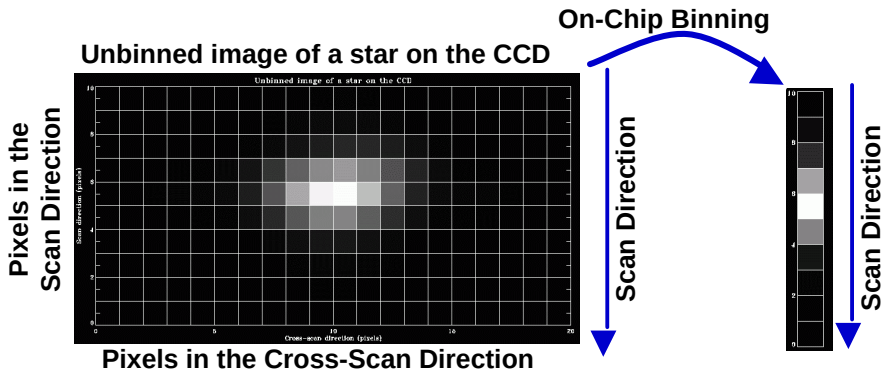
- The FAME Focal Plane
  - 24 2k·4k CCDs Arranged Around a 1.1° Diameter Field of View
  - Devices Marked With 'P' Are the 4 Photometric CCDs and Devices Marked With 'A' Are the 20 Astrometric CCDs
  - The 6 Devices Marked With 'ND' Have Neutral Density Filters for Astrometry of Brighter Stars

- Telescope Produces Images of Stars Using 24 Large Format CCDs
  - Images of Stars Are Continually Traversing CCD Array As the Spacecraft Rotates
  - CCDs Use Time Delay Integration
  - Synchronization of CCD Clock Rate and Image Motion Is Assured Via Rotation Rate Sensors
  - Star Images Are Time Tagged, Windowed, and Transmitted to Earth
  - 6 CCDs Are Covered by Neutral Density Filters for Astrometry of Bright Stars

Fame Error Sources

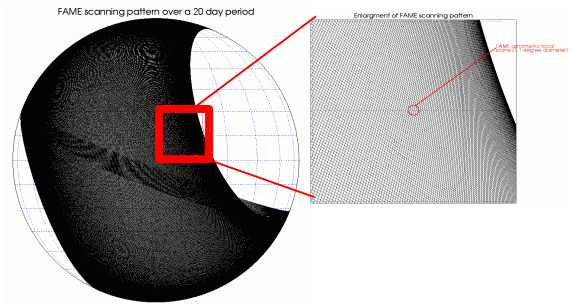
- CCD Characteristics
  - Read Noise, QE Variation, etc.
- Instrument Alignment
  - PSF Variations
- Instrument Stability
  - Thermal Effects
- Spacecraft
  - Knowledge of Spacecraft Velocity
- Stellar/External
  - Photon Statistics

On-Board Data Processing



- The Data From Most Stars Are Binned by 20 in the Cross-Scan Direction on the CCD Before Being Read-Out

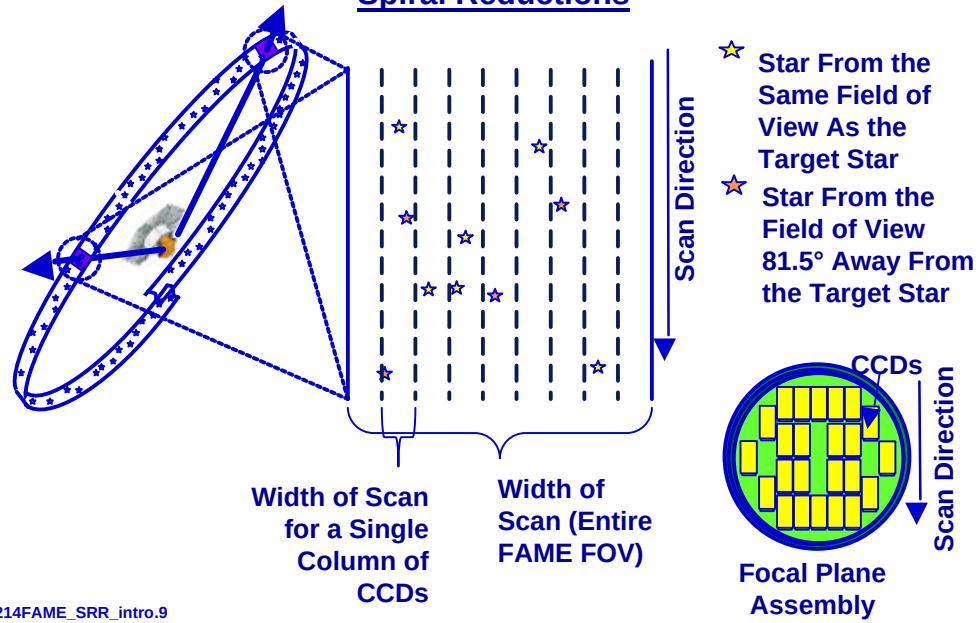
Sphere Reconstruction



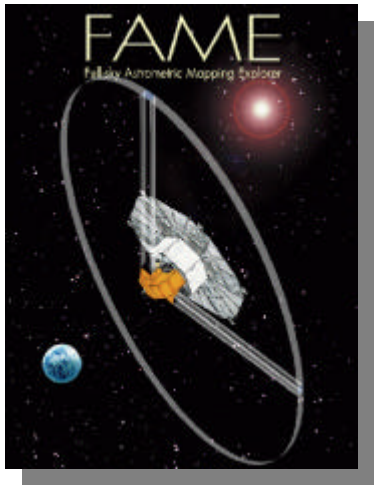
FAME Scan Pattern - The FAME Spacecraft Rotates With a 40 Minute Period Scanning the Two Apertures Across a Great Circle on the Sky. The 20 Day Precession of the Spacecraft About the Sun-spacecraft Line Results in FAME Covering the Entire Sky Except for Exclusion Zones Within 45° of the Sun and the Anti-sun Direction Every 20 Days.

- Use a Subset of the Stars to Globally Tie the Spirals Together Into a Sphere

Spiral Reductions

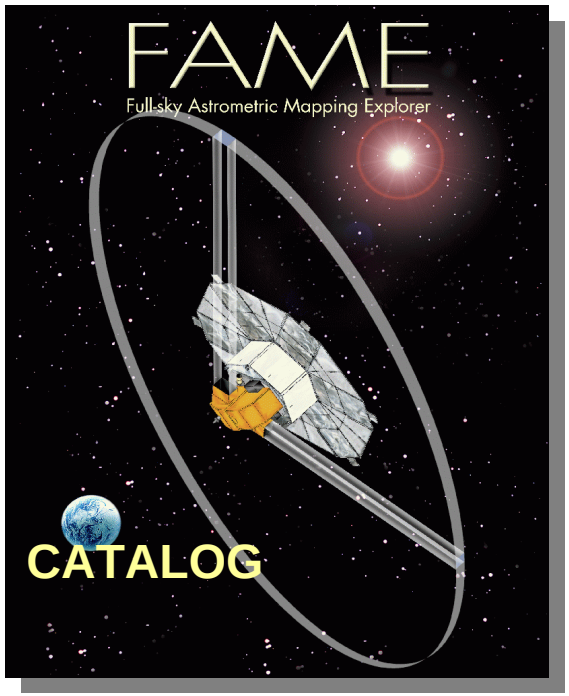


Catalog



FAME Catalog

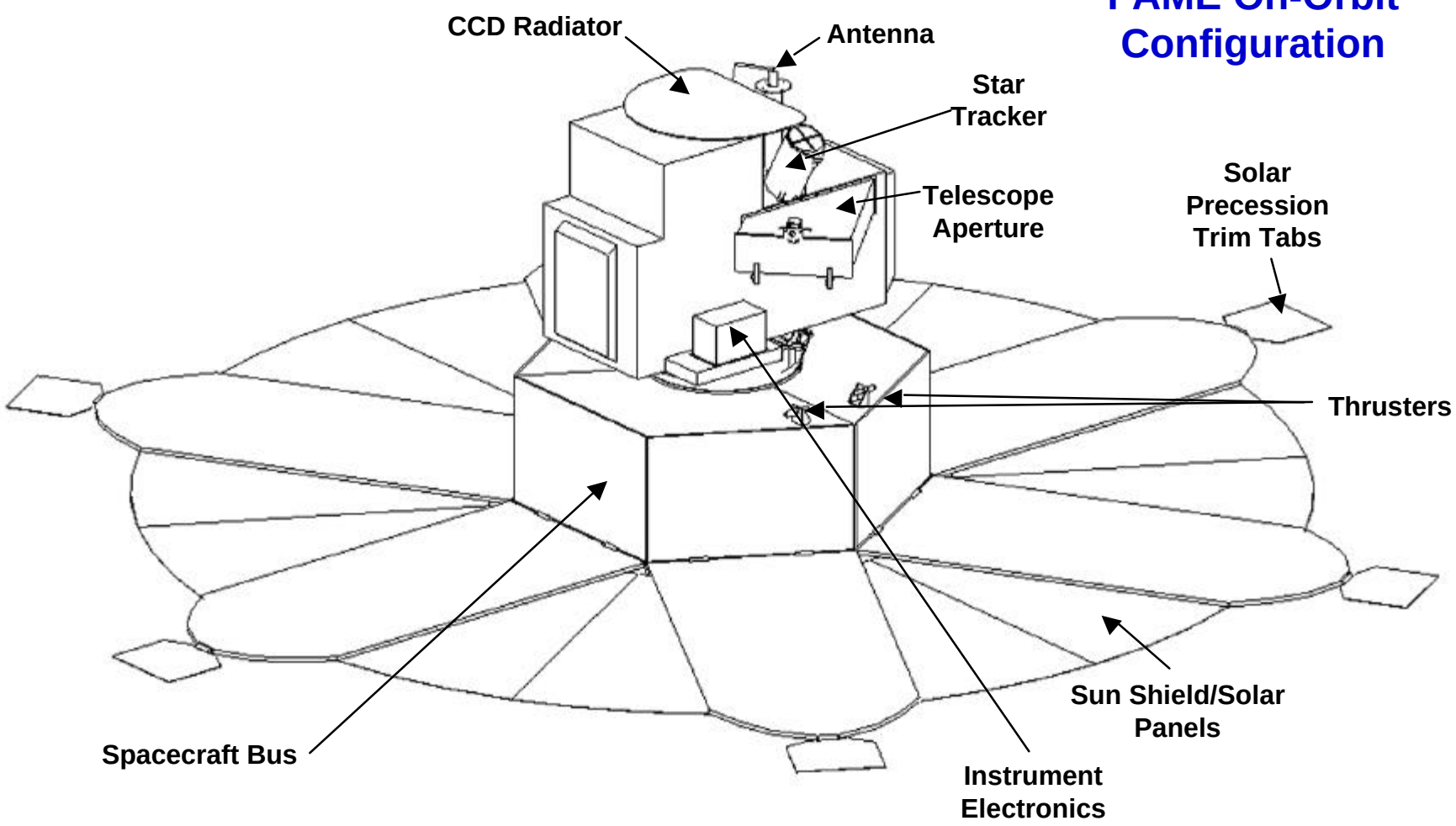
- **Catalog Available 3½ Years After Launch**
- **Complete Catalog From the Extended Mission Available 6 Years After Launch**
- **90-95% of FAME Customers Will Want the Complete Catalog With Nominal Positions, Parallaxes, Proper Motions, and Photometry**
- **The Other 5-10% Will Be Interested in Variations of a Subset of the Catalog Over Time**



The Study of Fundamental Properties of a Large Sample of Stars Is Needed to Answer Many Key Astrophysical Questions

FAME Spacecraft

FAME On-Orbit Configuration

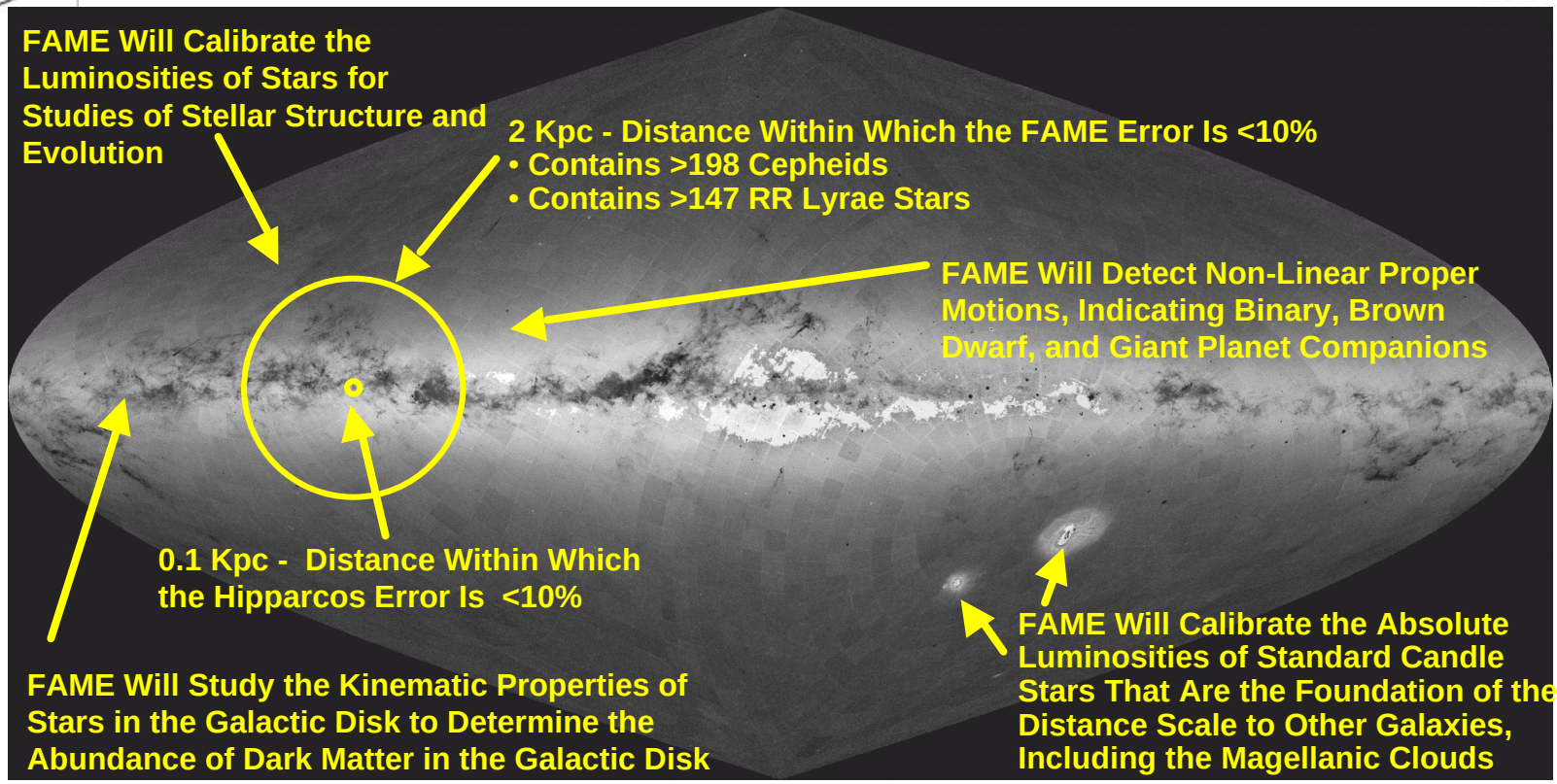


Spacecraft Design Uses Component Heritage From *Clementine*

FAME Schedule

- **Phase A Concept Study**
  - **February - June 1999**
- **Phase B**
  - **September 2000 - September 2001**
- **Phase C**
  - **October 2001 - June 2002**
- **Phase D**
  - **July 2002 - October 2004**
- **Launch**
  - **October 2004**
- **Phase E**
  - **November 2004 - May 2008**
- **DoD Extended Mission**
  - **June 2007 - November 2010**

FAME Coverage of the Milky Way



- FAME Science
  - FAME Will Map Our Quadrant of the Galaxy Out to 2 Kpc From the Sun Providing the Information Needed to Calibrate the Standard Candles That Define the Extragalactic Distance Scale, Calibrate the Absolute Luminosities of Stars of All Spectral Types for Studies of Stellar Structure and Evolution, and Detect Orbital Motions Caused by Brown Dwarfs and Giant Planets
  - FAME Will Not Only Improve on the Accuracies of Star Positions Determined by Hipparcos but Also Expand the Volume of Space for Which Accurate Positions Are Known by a Factor of 8,000

Timeliness of FAME

- **A Major Catalog of Accurate Fundamental Stellar Properties Will Enable Advances Across Numerous Branches of Astrophysics**
- **FAME Will Define a Reference Grid That Can Be Used for SIM, TPF, and Space Navigation**
- **FAME Will Identify Interesting Targets for SIM and TPF, Increasing Their Scientific Return**
- **FAME Is an Appropriate Stepping Stone Between Hipparcos and GAIA**
- **Large CCD Array Cameras Are Now Routinely Built for Ground Applications and Are Ready for Space**

FAME Summary

- **Calibrate the Zero Point of the Extragalactic Distance Scale to 1%**
- **Determine Absolute Luminosities of a Wide Range of Spectral Types**
- **Detect a Meaningful Statistical Sample of Companion Stars, Brown Dwarfs, and Giant Planets**
- **Enable Studies of the Kinematics of Our Galaxy, Including the Effect of Dark Matter in the Disk**
- **Characterize Stellar Variability of a Large Sample of Stars at the 0.1% Level**
- **Define an Optical Reference Frame for Future Scientific Endeavors**

FAME Science Team

- Dr. John Bahcall, Princeton
- Dr. Charles Beichman, Caltech
- Dr. Alan Boss, Carnegie Inst. Washington
- Dr. Christian DeVegt, U. Hamburg
- Dr. George Gatewood, U. Pittsburg
- Dr. Marvin Germain, USNO
- Dr. Andrew Gould, Ohio State
- Dr. Thomas P. Greene, NASA Ames
- Dr. Scott Horner, USNO
- Dr. John Huchra, CfA
- Dr. William H. Jefferys, U. Texas
- Dr. Kenneth Johnston, USNO
- Dr. David Latham, CfA
- Dr. David Monet, USNO
- Dr. Marc Murison, USNO
- Dr. James Phillips, SAO
- Dr. Robert Reasenberg, SAO
- Dr. Siegfried Röser, Astronomisches Rechen-Institut
- Dr. Allan Sandage, Carnegie Obs.
- Dr. P. Kenneth Seidelmann, USNO
- Dr. Mike Shao, JPL
- Dr. Irwin I. Shapiro, CfA
- Mr. Sean Urban, USNO
- Dr. William Van Altena, Yale
- Dr. Donald York, U. Chicago